



Comparative Cost Of California Central Station Electricity Generation Technologies

*Energy Policy Report Proceeding
Docket 02-IEP-01
Publication No. 100-03-001SD*

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February 26, 2003



Purpose Of The Report

- Describe technologies for system modeling
- Provide information / answer questions for:
 - Commissioners
 - Public
 - Other agencies
- Help energy portfolio managers to screen resource options



The Scope

Focused the analysis on new utility size power plants. We did not address the DG level technology such as small PV or biomass technologies.



Methodology

Levelized Cost

The levelized costs can be interpreted as a constant level of revenue necessary each year to recover all the expenses over the life of a power plant.

Levelized cost of any power plant is a function of all the fixed and varying annual costs (capital , O&M, and fuel.)



- ## Capital Cost

- 1 Debt financing

- Structured terms of the loan (L/A, #Years, rate)
- Requires periodic payments and securities of repayments

- 2 Equity financing

- Repaid from the residual revenues
- Runs the risk of not being fully repaid



- ## O & M Costs

O&M costs are the annual operation and maintenance that are independent of plant's output, but would cease if the plant operations ended. Labor, management, and insurance are typical O&M costs.

These costs do not vary to the operation mode (intermediate to peaking) of the plant.



- ## Variable Cost
- Variable costs are very sensitive to the operation of the plant and derived from fuel consumption, maintenance expenditures for force outages and other input costs driven directly by hourly plant operation.
- Fuel costs change over time and are often unpredictable compared to the other cost components.
- We used CEC Dec. 2002 NG price forecast.



Financial Assumptions

Category	Capital Structure	Capital Cost
Equity	39.1%	16.0%
Debt	60.9%	7.4%
Discount Rate/Net Capital Cost	10.8%	
Inflation Rate	2.0%	
Debt Coverage Ratio - Minimum	1.5	
Debt Coverage Ratio - Average	1.8	
Loan/Debt Term (years)	12.0	



Results

Technology	Fuel	Operative Mode	Gross Capacity (MW)	Direct Cost Levelized (cents/kWh)
Combined Cycle				
	Natural Gas	Baseload	500	4.58
Simple Cycle				
	Natural Gas	Peaking	100	14.06
Wind				
	None	Variable	100	5.42
Hydropower				
	Water	Load-Following	100	6.58
Solar Thermal				
PV	None	Load-Following	50	48.4
Parabolic Trough	None	Load-Following	110	22.45
Parabolic Trough- TES	None	Load-Following	110	18.09
Parabolic Trough-Gas	Natural Gas	Load-Following	110	14.81
Stirling Dish	None	Load-Following	31.5	16.06
Fuel Cells				
PEM	Natural Gas	Baseload	25	15.42
Phosphoric Acid	Natural Gas	Baseload	25	20.89
Molten Carbonate	Natural Gas	Baseload	25	9.65
Solid Oxide	Natural Gas	Baseload	25	11.12
Hybrid	Natural Gas	Baseload	25	9.10
Geothermal				
Flash	Water	Baseload	50	4.69
Binary	Water	Baseload	35	7.61



Caveats

1. The cost of these technologies are not site specific and the following costs are not included in the analysis:

- Cost of Permitting Applications varies and for each AQMD
- Siting cost will vary based on the location of the project
(AQ - water - biology - land use - mitigation- ..etc)
- Cost of removing an existing facility (if there is one)
is not included.
- Infrastructure cost (transmission, gas, water lines)



2. Normal market condition

- peace
- gas prices forecast (CEC long term forecast)

3. Corporate credit status

- corporate credit & borrowing power
- Interest rate & equity portion might change

4. Hedging NG cost and price volatility are not counted for.



Caution

These numbers are not **alone** sufficient to choose between technologies. The choice will depend on the resource system portfolio and the performance of the resource option.



Workshop Questions

- Are there any other costs to consider for developing renewable technologies in California?
- Do you have better cost numbers (\$/KWH) for any of the technologies? What are the assumptions used in driving these costs?



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